LEVELL

R.C. OSCILLATORS

TYPE TG200 SERIES

INSTRUCTION MANUAL

OPERATING INSTRUCTIONS

for

R.C. OSCILLATORS

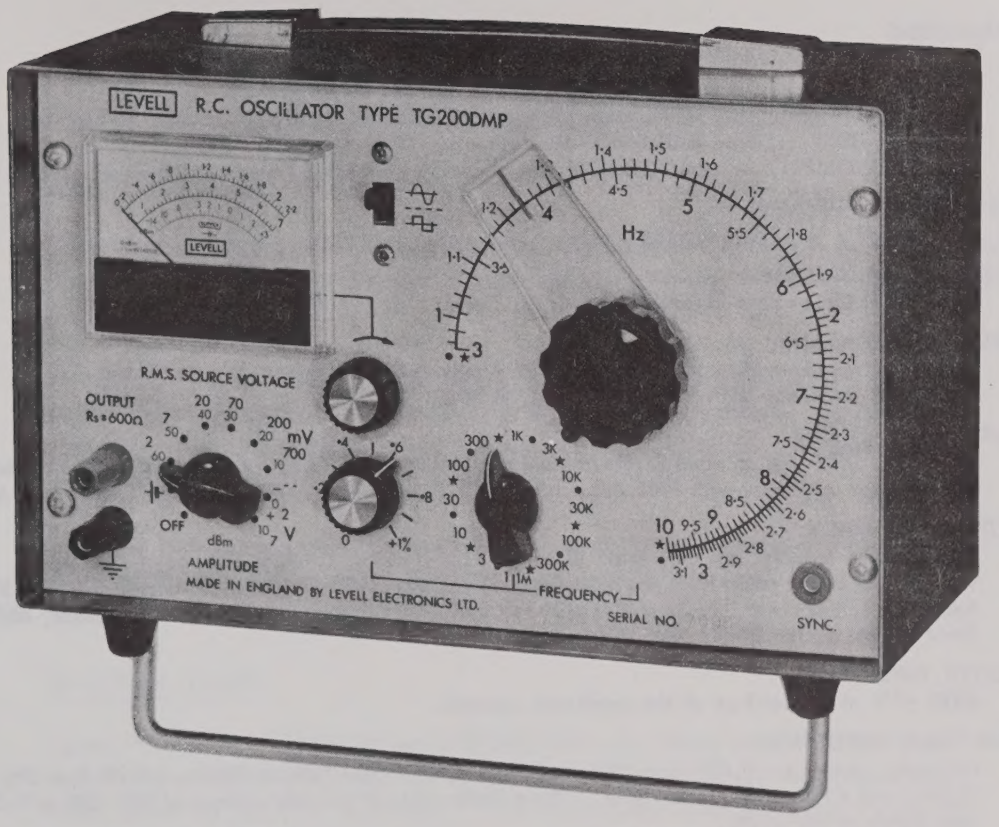
TYPE TG200 SERIES

GUARANTEE

We undertake to repair, or replace free of charge, any components that fail within 12 months of the date of purchase of an instrument provided that the instrument is not, in our opinion, modified or misused. Instruments returned by post should be well packed to avoid damage. We recommend the use of two strong cartons, one to fit closely around the instrument and the other large enough to float the small carton in at least 2" thickness of wood wool.

LEVELL ELECTRONICS LIMITED, MOXON STREET, BARNET, HERTS.,ENGLAND.

Telephone: 01-440 8686
01-449 5028



- **1Hz to 1MHz**
- **SINE OR SQUARE**
- **7Vr.m.s. OUTPUT**
- **LOW DISTORTION**
- **SYNC. FACILITY**
- **STABLE AMPLITUDE**

A frequency coverage of 1Hz to 1MHz is provided on these solid state R.C. Oscillators which are available in versions that generate sine waves only or sine and square waves with a fine frequency control on one version to permit incremental changes as small as 0.03%. An output up to 7V r.m.s. is generated by all versions but choice is available as to whether or not an output meter is fitted. Internal long life batteries provide power for these instruments but operation from an A.C. mains supply is possible when a LEVELL stabilised Power Supply Unit is fitted in place of the batteries.

The patented oscillator circuit arrangement uses a single track linear potentiometer as the variable frequency control. This gives a much longer working life for the component when compared with the dual track logarithmic potentiometers that are often used in Wien bridge circuits. In addition, variation of the potentiometer over the audio range is not accompanied by amplitude bounce which is characteristic of Wien bridge circuits. The output of the oscillator is stabilised by a thermistor and considerable negative feedback is applied to ensure that the waveform has a low harmonic content.

The square wave output of the dual waveform versions is produced by a trigger circuit to ensure that the rise time is irrespective of the frequency.

The output from the oscillator circuit, or the trigger circuit, is fed to the output terminals via a low distortion power amplifier. This acts as a buffer to prevent modulation of the oscillator by signals picked up on the output leads. A sync. socket is provided to give a constant sinusoidal signal for locking other equipment such as an oscilloscope time base. The oscillator can also be locked to an external signal which is fed into the sync. socket.

VARIATIONS

Type TG200 : Sine wave output only. No output meter.
Type TG200D : Sine and square wave outputs. No output meter.
Type TG200M : Sine wave output only. Output meter fitted.
Type TG200DM : Sine and square wave outputs. Output meter fitted.
Type TG200DMP : As type TG200DM plus 0 to 1% calibrated fine frequency control.

FREQUENCY COVERAGE

1Hz to 1MHz in 12 overlapping ranges.

FREQUENCY ACCURACY

$\pm 1.5\% \pm 0.01$Hz up to 100kHz, $\pm 2\%$ up to 1MHz.

FREQUENCY STABILITY

Change of frequency for $\pm 15\%$ shift on 33V supply is $< \pm 0.1\%$ from 1Hz to 50kHz.
Change of frequency with temperature is $< \pm 0.025\%/^{\circ}C$.

OUTPUT AMPLITUDE

7V r.m.s. (20V p-p on sine) source voltage reducible to $<200\mu V$ by a continuously variable control and switched attenuator with 10dB steps up to 70dB. Power output -74dBm/+13dBm (20mW) into 600Ω.

OUTPUT ACCURACY

Versions with a meter are calibrated 0 to 7V r.m.s. source voltage, accuracy $\pm 2\%$ f.s.d.
Versions without a meter have the output control calibrated 0 to 7V r.m.s., accuracy $\pm 5\% \pm 5\%$ f.s.d.
Additional scales cover 0 to 2V and -14dBm to +3dBm. The attenuator error on 2V, 700mV, 200mV and 70mV is $\pm 2\%$ and on 20mV, 7mV and 2mV is $\pm 4\%$.

OUTPUT IMPEDANCE

$600\Omega \pm 1\%$ at all settings of the amplitude controls.

SINE WAVE DISTORTION

Harmonic content is $<0.05\%$ from 50Hz to 15kHz, $<0.1\%$ from 10Hz to 50kHz, $<0.2\%$ from 5Hz to 150kHz and $<1\%$ at 1Hz and 1MHz. These limits apply at a supply voltage of 33V -5% to +15%, they double at 33V -15%.

SINE WAVE AMPLITUDE STABILITY

Amplitude variation with frequency is $< \pm 1\%$ up to 300kHz and $< \pm 3\%$ at 1MHz.
Amplitude variation with temperature is $< \pm 0.3\%/^{\circ}C$. Amplitude variation for $\pm 15\%$ change on 33V supply is $< \pm 0.1\%$ up to 150kHz and $< \pm 0.3\%$ at 1MHz.

SQUARE WAVE CHARACTERISTICS

Rise time is <150nS with no droop at low frequencies. Variation of p-p amplitude with frequency is $< \pm 1\%$ up to 300kHz and $< \pm 3\%$ at 1MHz. The r.m.s. amplitude falls about 10% at 1MHz due to rise time. Amplitude variation is $< \pm 0.2\%/^{\circ}C$ and $< \pm 3\%$ for $\pm 15\%$ change on 33V supply.

SYNC OUTPUT

Sine wave in phase with the output, amplitude is >1V r.m.s., source resistance $3.3k\Omega$.

SYNC INPUT

The frequency can be locked to an external signal over a range of $\pm 1\%$ per volt r.m.s. input up to 10V maximum. The frequency control then varies the phase of the output.

TEMPERATURE

The above characteristics are at $18^{\circ}C$ to $28^{\circ}C$ with only minor divergencies from $-5^{\circ}C$ to $+45^{\circ}C$.

POWER SUPPLY

Four Ever Ready type PP9 batteries provide 33V $\pm 15\%$ centre earthed supply. Consumption is typically 12mA on sine and 16mA on square waves giving an average battery life of 300 hours. Operation from A.C. mains is possible when LEVELL Power Unit type PU33 is fitted in place of the batteries. The Power Unit output is 33V $\pm 5\%$ stabilised against supply variations.

SIZE & WEIGHT

180mm x 260mm x 140mm. 4.5kg.

CARRYING CASES

Cases are available as optional extras. They are stiffened with board and felt lined. Shoulder straps are detachable and it is possible to use an instrument whilst in a case.

OPERATING INSTRUCTIONS FOR LEVELL TG200 R.C. OSCILLATORS

1. Connection of Power Supply

Remove the back panel from the case and connect four 9V batteries Ever Ready type PP9 or equivalent by means of the snap fastener connections provided.

A LEVELL Power Supply Unit type PU33 may be fitted in place of the batteries when operation is required from an A.C. mains supply. The earth connection on the Power Unit must be joined to the case of the instrument.

Replace the back panel taking care to ensure that the back screws are tight so that there is a good electrical connection between the back panel and the instrument case.

2. To Check Supply

Types TG200M, TG200DM and TG200DMP are fitted with a meter that should have the mechanical set zero screw adjusted when the instrument is switched to the OFF position. The attenuator switch should be set to the "Test supply" position and 10 seconds allowed for the pointer to settle to a stable reading. The supply limits are marked on the meter scale.

Types TG200 and TG200D are fitted with an indicator lamp that glows in the "Test Supply" condition when the instrument is fitted with batteries that are in good condition.

3. To Use the Oscillator

Turn the two "Amplitude" controls fully clockwise to obtain maximum output from the oscillator. Allow 30 seconds for the oscillator to settle to a steady state after switching on. The frequency may then be varied by adjustment of the range switch and frequency dial.

The output waveform of type TG200D, TG200DM and TG200DMP may be selected to be sine or square by means of the slide switch that is pictorially marked. However, the output on the "SYNC" socket remains a constant amplitude sine wave irrespective of the settings of the amplitude controls and the Sine/square switch.

The amplitude control switch is marked in terms of both voltage and dBm. The voltage markings refer to the r.m.s. source voltage that is indicated at the upper ends of the voltage scales on the meters of types TG200M, TG200DM and TG200DMP or the calibrated amplitude potentiometers of types TG200 and TG200D. The amplitude control switch introduces attenuation in steps of 10dB up to 70dB in series with the output terminals of the oscillator. The control is marked in terms of dBm with 0dBm meaning a power level of 1mW produced into a load of 600Ω. The control steps of 10dBm from -60dBm to +10dBm are added to the reading on the calibrated scale of -14dBm to +3dBm in order to give the available power level into a termination of 600Ω.

Fine adjustment of the output level is made by the amplitude control potentiometer that varies the signal level over a range of at least 20dB without affecting the output impedance of the oscillator which remains at 600Ω at all output levels and all frequencies. It is not necessary to terminate the oscillator with a matched load of 600Ω as variation of the load impedance has a negligible effect upon the oscillator frequency. Low load impedances may be placed across the output terminals to obtain output currents up to 11mA r.m.s. This feature permits a resistor of say 82Ω to be placed across the output terminals to lower the source impedance to 72Ω for driving a coaxial cable of this characteristic impedance. Matching of the source to the load becomes mainly of importance at the high frequency end of the oscillator range on square wave output when it is desired to maintain a fast rise time and avoid creating H.F. ringing in reactive loads and test leads.

The frequency range switch is marked alternately with a dot and a star which refer to the two scales that exist on the variable frequency control. The numbers on either side of the symbol give the limits in Hz at each end of the selected range.

4. To Use The SYNC. Facility

There are two uses for the socket marked SYNC. The first is to provide a sine wave signal output of constant amplitude of about 1.5V r.m.s. for synchronising other items such as an oscilloscope time base. The second use is to accept a signal input to lock the oscillator to another source.

The sync. output can be used to drive a load impedance of the order of 100kΩ in parallel with 50pF with negligible effect upon the oscillator performance. Placing a short circuit between the sync. socket and earth only affects the oscillator by pulling the frequency about 1% at the very top end of the frequency coverage.

The lock facility permits the oscillator to be synchronised to a low level frequency standard such as a crystal controlled oscillator that can provide an output of about 1V r.m.s. into a load of 3.3kΩ. The main oscillator output then becomes a standard source when the frequency dial is tuned to the frequency of the crystal controlled oscillator. In this respect the oscillator may be considered as then acting as a tuned power amplifier with the advantage that the output level is stabilised against amplitude variations on the output of the crystal controlled oscillator.

5. Adjustment of Preset Controls

A number of preset adjustments are provided to permit optimum setting of the performance of the instrument. These adjustments are set prior to despatch of the instrument from the factory when operating from supplies of ±16.5V ±5% at a temperature of 20°C to 25°C. Readjustment of these controls will not normally be required for many months unless the instrument has had a component failure.

The following items of test equipment are required during the process of adjustment of the preset controls:-

(a) Frequency meter capable of measuring frequencies from 100Hz to 1MHz to an accuracy better than ±0.1%.

(b) D.C. Voltmeter with sensitivity better than ±10mV and input impedance greater than 10kΩ.

(c) A.C. Voltmeter with calibration accuracy better than ±0.5% at 5V 1kHz and input impedance greater than 500kΩ.

The first 10 adjustments are made to controls located on the main printed circuit board which is visible when the back panel is removed. The two square wave adjustments are located on the small printed circuit board that is behind the battery compartment at the centre of the instrument. The positions of the various controls can be seen on the following diagram.

Adjustments must be made in the following order:-

(1) Set to 5V output on sine waves at 1kHz. Place the D.C. Voltmeter across the output connections. Adjust the Z control for $\leq \pm$ 10mV D.C. on the output.

(2) Transfer the D.C. Voltmeter to measure between the SYNC. socket and earth. There should be a potential of about -70mV present on the 1kHz to 3kHz range. Switch to the 3Hz to 10Hz range and adjust the S control at 10Hz until the same D.C. level is obtained.

(3) On TG200M, TG200DM and TG200DMP, adjust the METER control to vary the sensitivity of the meter so that it reads correct at 5V output from the oscillator at 1kHz on sine wave.

(4) On TG200M, TG200DM and TG200DMP, turn the amplitude control to maximum and adjust the SINE control so the output is 7.5V measured on a meter across the output terminals. On the TG200 and TG200D, turn the amplitude control to 5V on the calibrated scale and adjust the SINE control so the output is 5V across the output terminals.

(5) Set the amplitude to 5V approximately and adjust the frequency controls until the frequency on the 100Hz to 300Hz range is set at 100Hz i.e. the period is 10,000µS. Turn only the range switch to the 3kHz to 10kHz range and adjust TC1 + TC2 until the frequency is 3162.3Hz i.e. the period is 316.23µS. Increasing either TC1 or TC2 reduces the frequency.

(6) Set the frequency on the 100Hz to 300Hz range to 300Hz i.e. a period of 3333.3µS. Turn only the range switch to the 3kHz to 10kHz range and measure the frequency. It should be 9486.9Hz $\pm$ 0.1% i.e. the period should be 105.41µS $\pm$ 0.1%.

When the measured value is outside these limits adjust the upper trimmer TC2 to give an error in the opposite direction of twice the magnitude of the observed error and then adjust the lower trimmer TC1 to correct this error i.e. if the period measured was 105.0µS instead of 105.41µS, adjust TC2 until the period is 106.23µS and then adjust TC2 to obtain 105.41µS.

The object of this method of adjustment is to vary the capacity ratio TC1:TC2 but not to vary the product capacity of TC1 X TC2 as this affects the preceding adjustment at the low end of the scale. Repeat (5) and (6) until no further adjustment is required.

(7) Turn to the 3kHz to 10kHz range and adjust the L control at 4kHz setting on the frequency dial.

(8) Rotate the dial to 8kHz and adjust the H control to obtain the correct frequency. Observe the errors present at dial settings of 3, 4, 5, 6..... 10kHz. The errors at all points should be less than $\pm$ 1%. Adjust the L and H controls in order to obtain optimum tracking i.e. to balance the errors so that no cardinal point is worse than $\pm$ 1% in error.

(9) Adjust the 300kHz trimmer so that the error at 300kHz is balanced to minimum at the 300kHz points on the top 2 ranges. Place the back panel in position before taking measurements as the frequency is affected by the presence of this screening plate.

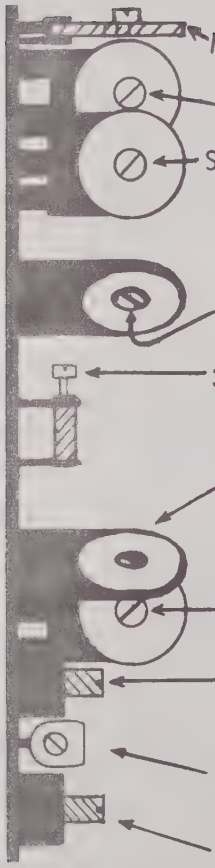
(10) Adjust the 1MHz trimmer so that tracking is optimum from 700kHz to 1MHz with the back panel in position. Repeat (9) and (10) until optimum conditions are obtained for the tracking of the scale on the top two ranges.

(11) On TG200D, TG200DM and TG200DMP adjust the square wave D.C. zero control until the D.C. level superimposed on a 5V 1kHz output is less than $\pm$10mV.

(12) On TG200D, TG200DM and TG200DMP adjust the square wave output control until the r.m.s. output on square waves is same as that on sine waves at 5V 1kHz.

PRESET ADJUSTMENTS OF TG200 SERIES

SETTING ORDER & CONDITIONS



(3) 5V output at 1kHz on sine wave. Absent on TG200 and TG200D.

(1) D.C. zero on sine output at 5V 1kHz.

(4) 7.5V maximum output at 1kHz on TG200M and TG200DM. 5V at 5V on scale of TG200 and TG200D.

(7) At low end of frequency scale in conjunction with H control.

(9) For 300kHz optimum on top two ranges (Interacts with 1M control)

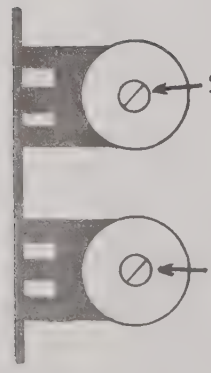
(8) At high end of frequency scale in conjunction with L control for optimum tracking on 3kHz to 10kHz.

(2) For same D.C. level on SYNC at 10Hz as exists at 2kHz.

(5) TC1 + TC2 set so frequency is 3162.3Hz on 3-10kHz at same dial setting as that giving 100Hz on 100-300Hz.

(10) For 700kHz to 1MHz optimum tracking. (Interacts with 300kHz control)

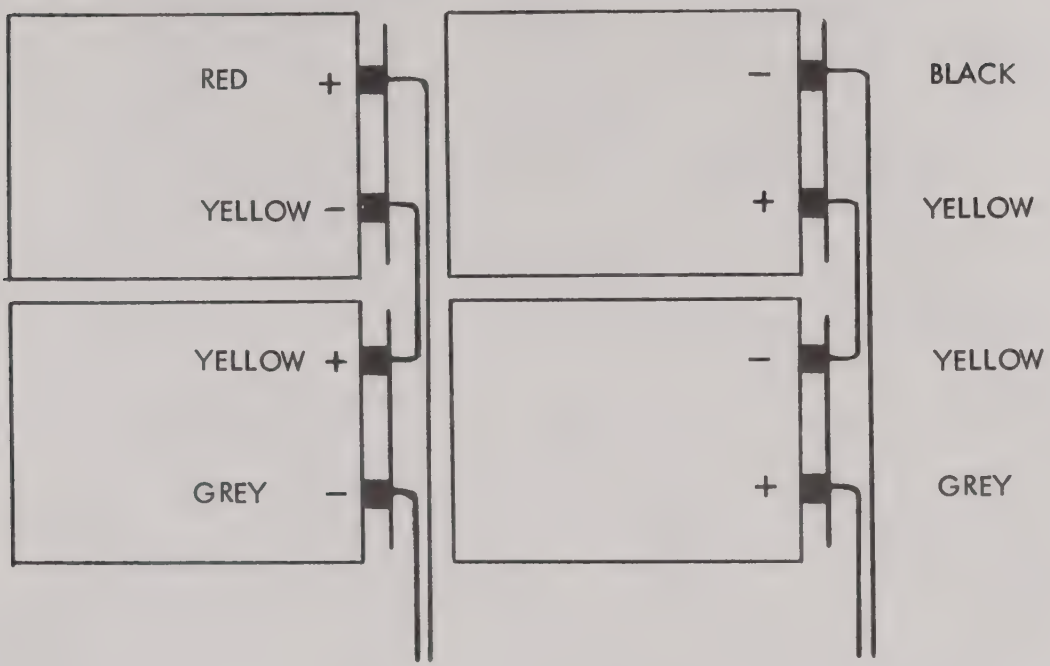
(6) TC1 : TC2 set so frequency is 9486.9Hz on 3-10kHz at same dial setting as that giving 300Hz on 100-300Hz.



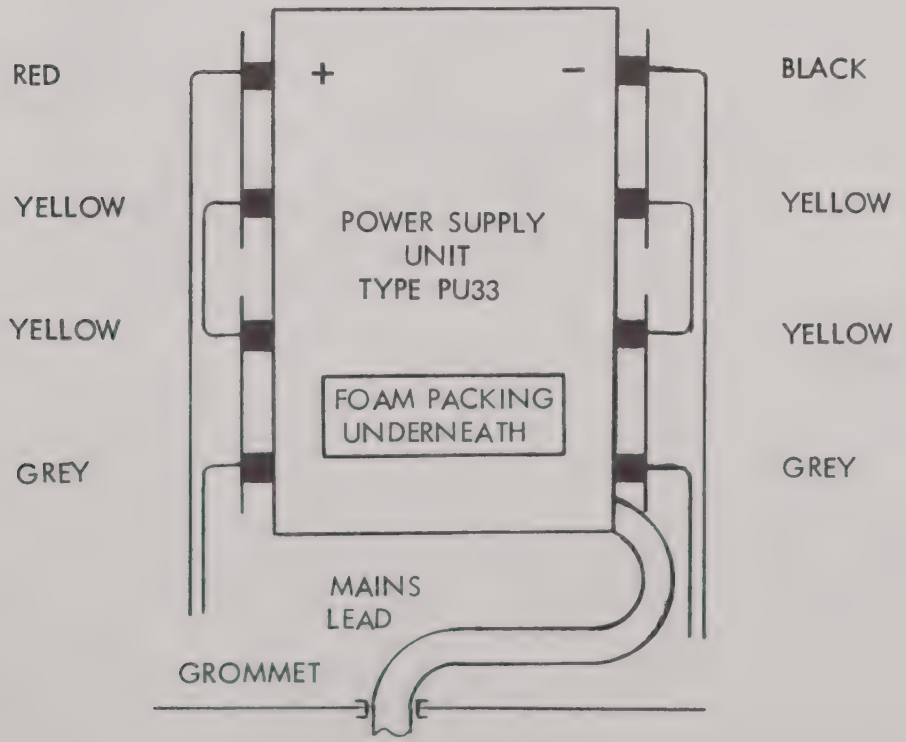
(12) R.M.S. output on square to be same as sine at 5V 1kHz.

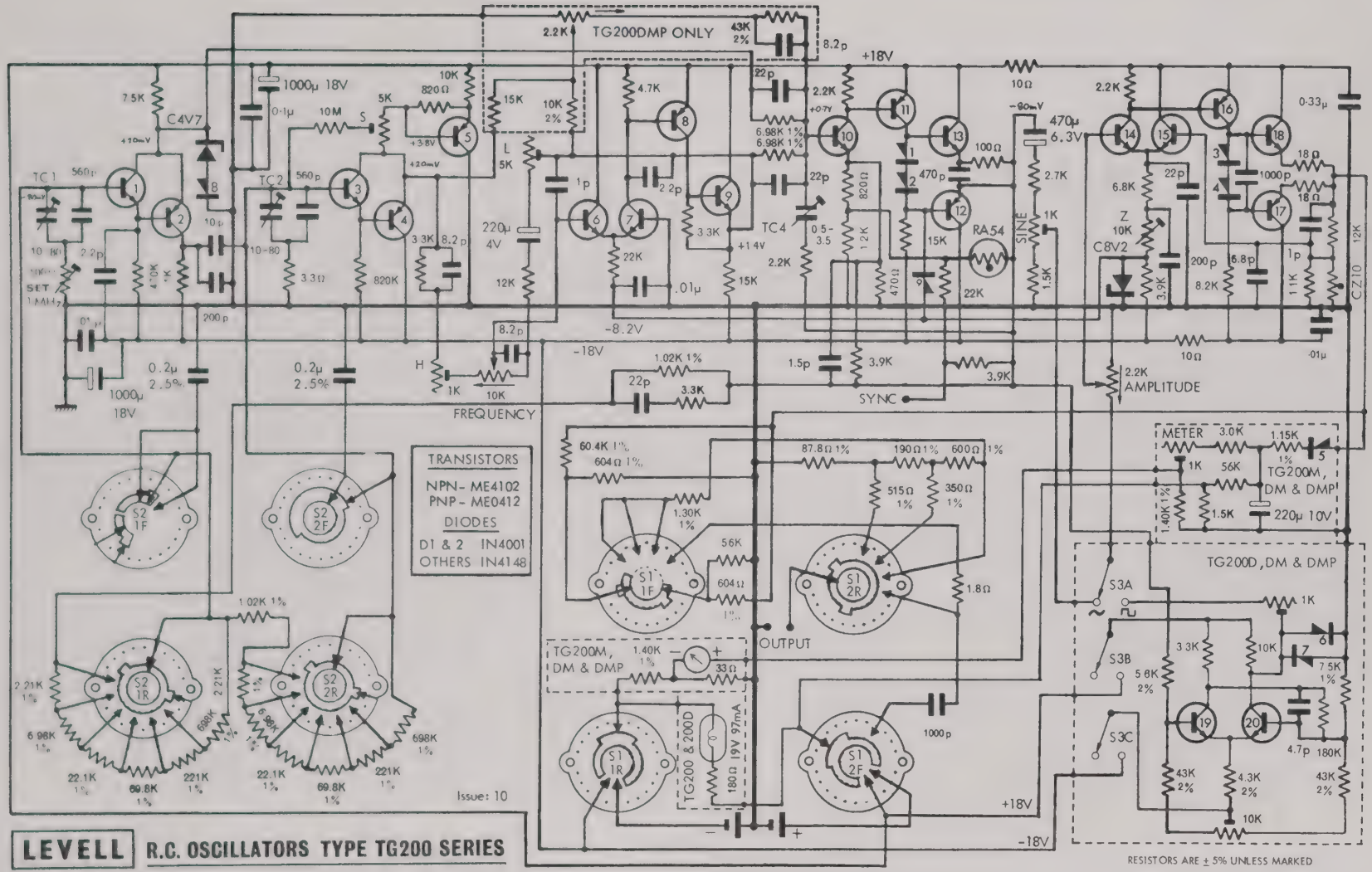
(11) D.C. zero on sq. output at 5V 1kHz.

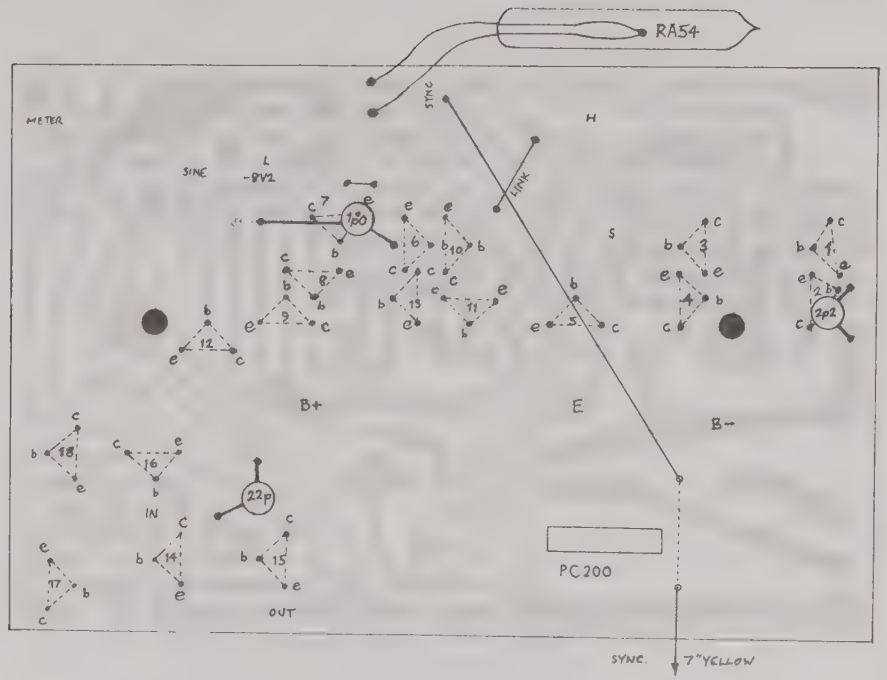
CONNECTIONS FOR PP9 BATTERIES IN TG200 SERIES



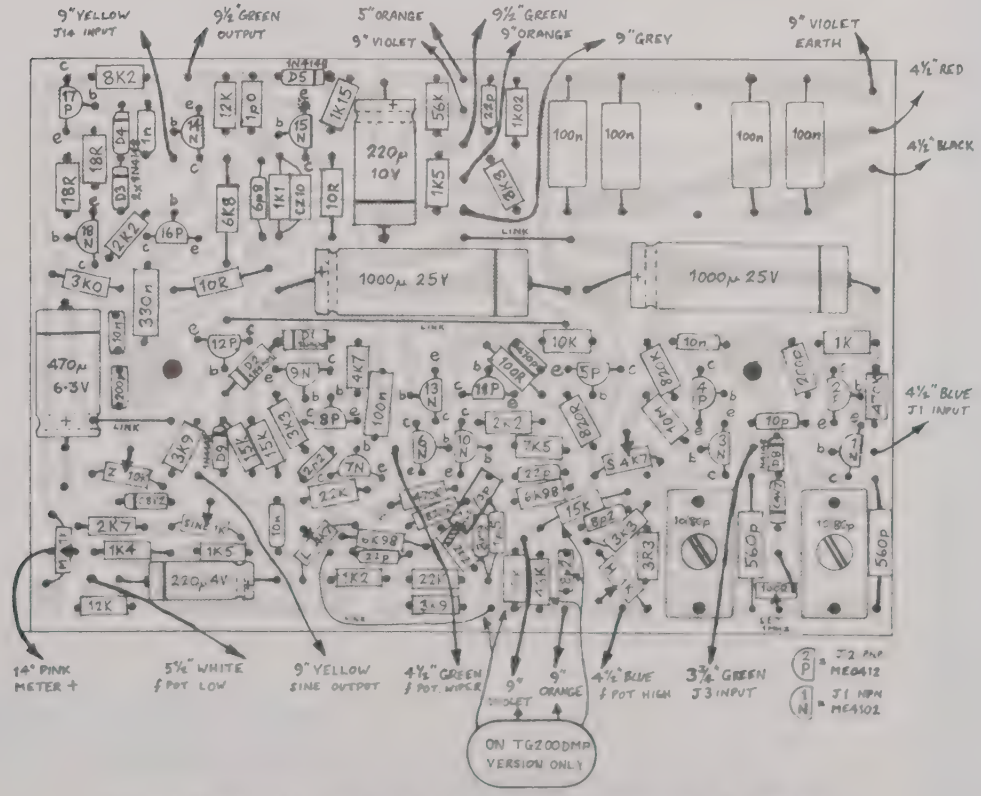
CONNECTIONS FOR PU33 IN TG200 SERIES




TG200DMP ONLY
+18V
-18V
-8.2V
C4V7
C8V2
RA54
SINE
TC1
TC2
TC4
SET 1 MHz
FREQUENCY
SYNC
AMPLITUDE
OUTPUT
METER
TG200M, DM & DMP
TG200D, DM & DMP
TG200 & 200D
TRANSISTORS
NPN - ME4102
PNP - ME0412
DIODES
D1 & 2 IN4001
OTHERS IN4148
Issue: 10
LEVELL
R.C. OSCILLATORS TYPE TG200 SERIES
RESISTORS ARE ± 5% UNLESS MARKED



PRINTED SIDE OF TG200DMP PRINTED CIRCUIT.



COMPONENT SIDE OF TG200DMP PRINTED CIRCUIT.

SHORT FORM CATALOGUE

FUNCTION GENERATOR

TG301

FREQUENCY	0.02Hz to 2.1MHz in 7 decades ranges with overlap. Control calibrated from 0.05 to 2.1.
ACCURACY	±5% of full scale on each range.
WAVEFORMS	Sine, square, triangle, pulse and ramp.
DC OFFSET	Variable up to ±10V from 50Ω superimposed on signal on main output.
MAIN OUTPUT	60mV to 20V peak to peak from 50Ω source. Variable 0/-30dB control plus 0/-20dB switched attenuator.
TTL OUTPUT	Fixed amplitude square wave/pulse to drive up to 20 standard TTL loads. Rise time <30ns.
VCF (EXT SWEEP)	1000 : 1 frequency ratio by application of 10V p-p.
POWER SUPPLY	100/120V or 200/250V AC supply limits, 50/60Hz. 10VA.
SIZE & WEIGHT	90 x 200 x 250mm. 2kg.

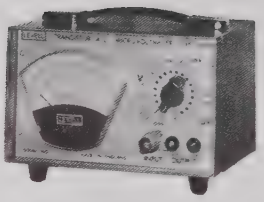
LEVELL ELECTRONICS LTD.

Moxon Street, High Barnet, Herts. EN5 5SD
Tel: 01-449 5028/440 8686

AC MICROVOLTMETERS

TM3 SERIES

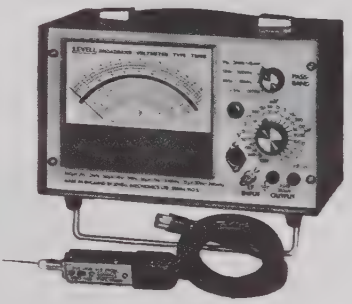
VOLTS & dB RANGES	15μV, 50μV, 150μV...500V fsd. Acc.±1% ±1% fsd ±1μV at 1kHz. −100, −90...+50dB. Scale −20dB/+6dB ref. 1mW/600Ω.
RESPONSE	±3dB from 1Hz to 3MHz, ±0.3dB from 4Hz to 1MHz above 500μV. TM3B filter switch : LF cut 10Hz, HF cut 100kHz, 10kHz or 350Hz.
INPUT Z	Above 50mV : 10MΩ < 20pf. On 50μV to 50mV : >5MΩ <50pf.
OUTPUT	150mV at fsd.
SIZE & WEIGHT	TM3A. 130 x 185 x 115mm. 2kg with battery. Meter scale 83mm. TM3B. 180 x 260 x 140mm. 3kg with battery. Meter scale 123mm with mirror.



BROADBAND VOLTMETERS

TM6 SERIES

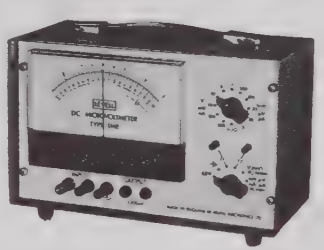
HF VOLTS & dB RANGES	1mV, 3mV, 10mV...3V fsd. Acc.±4%±1% fsd at 30MHz. −50, −40...+20dB. Scale −10dB/+3dB ref. 1mW/50Ω. ±0.7dB from 1MHz to 50MHz. ±3dB from 300kHz to 400MHz.
LF RANGES	As AC Microvoltmeters.
OUTPUT	Square wave at 20Hz on HF with amplitude proportional to square of input. As AC Microvoltmeters on LF.
SIZE & WEIGHT	TM6A. 130 x 185 x 115mm. 2.5kg with battery. Meter scale 83mm. TM6B. 180 x 260 x 140mm. 3kg with battery. Meter scale 127mm with mirror.



DC MICROVOLTMETER

TM8

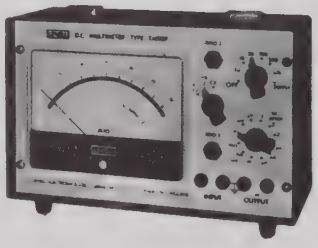
V RANGES	±3μV, ±10μV, ±30μV...±300V. Acc.±1.5% ±1.5% fsd ±0.15μV.
I RANGES	±3pA, ±10pA, ±30pA...±300nA. Acc.±2%±1.5% fsd ±0.2pA.
LOG RANGES	±1μV/1pA at ±10% fsd, ±30μV/30pA at ±60% fsd, ±300mV/300nA at ±fsd.
OUTPUT	±300mV at fsd. Source resistance 4.7kΩ.
SIZE & WEIGHT	180 x 260 x 140mm. 2.5kg with battery. Meter scale 120mm.



DC MULTIMETERS

TM9 SERIES

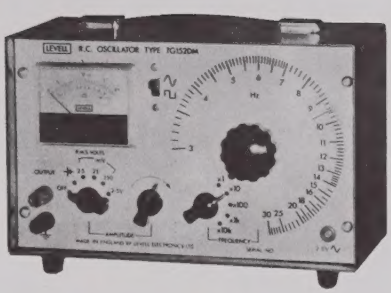
V RANGES	3μV, 10μV, 30μV...1kV. Acc.±1% ±1% fsd ±0.1μV. LZ & CZ scales.
I RANGES	3pA, 10pA, 30pA...1mA(1A for TM9BP). Acc.±2%±1% fsd ±0.3pA. LZ & CZ scales.
Ω RANGES	3Ω, 10Ω, 30Ω...1GΩ linear. Acc.±1% ±1% fsd up to 100MΩ.
OUTPUT	1V at fsd into > 1kΩ on LZ ranges.
SIZE & WEIGHT	TM9A. 130 x 185 x 115mm. 2kg with battery. Meter scale 83mm. TM9BP. 180 x 260 x 140mm. 3kg with battery. Meter scale 127mm with mirror.



DECADE BOXES

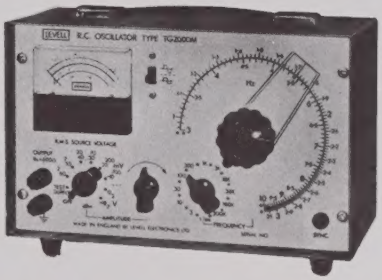
Type C410	4 decades, 10 to 111,110pF in 10pF steps. Acc.±1%±2pF.
Type R401	4 decades, 0 to 11,110Ω in 1Ω steps. Acc.±1%.
Type R410	4 decades, 0 to 111,100Ω in 10Ω steps. Acc.± 1%.
Type R601	6 decades, 0 to 1,111,110Ω in 1Ω steps. Acc.±1%.
Type R601S	6 decades, 0 to 1,111,110Ω in 1Ω steps. Acc.±0.3% ±3mΩ.
Type R610	6 decades, 0 to 11,111,100Ω in 10Ω steps. Acc.±1%.
Type R701	7 decades, 0 to 11,111,110Ω in 1Ω steps. Acc.± 1%.

RC OSCILLATORS



TG152 SERIES

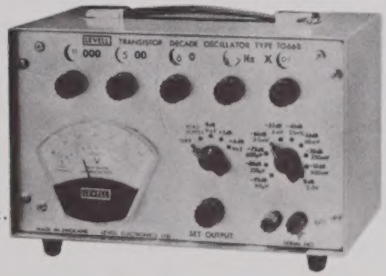
FREQUENCY	3Hz to 300kHz in 5 ranges.
ACCURACY	±2% ±0.1Hz up to 100kHz. ±3% up to 300kHz.
SINE OUTPUT	2.5V rms down to <200μV.
DISTORTION	<0.2% from 50Hz to 50kHz, <1% from 10Hz to 200kHz.
SQUARE OUTPUT	TG152D & DM. 2.5V peak down <200μV.
SYNC. OUTPUT	2.5V rms sine in phase with output.
METER SCALES	TG152DM only. 0/2.5V & -10/+10dB.
SIZE & WEIGHT	260 x 130 x 180mm. 3.4kg with batteries.



TG200 SERIES

FREQUENCY	1Hz to 1MHz in 12 ranges. 0 to 1% fine control on TG200DMP.
ACCURACY	±1.5%±0.01Hz up to 100kHz. ±2% up to 1MHz.
SINE OUTPUT	7V rms down to <200μV with Rs = 600Ω.
DISTORTION	<0.05% from 50Hz to 15kHz, <0.1% from 10Hz to 50kHz, <0.2% from 5Hz to 150kHz, <1% at 1Hz and 1MHz.
SQUARE OUTPUT	TG200D, DM & DMP only. 7V peak down to <200μV. Rise time <150nS.
SYNC. OUTPUT	>1V rms sine in phase with output.
SYNC. INPUT	±1% freq. lock range per volt rms.
METER SCALES	TG200DM & DMP only. 0/2V, 0/7V & -14/+6dBm.
SIZE & WEIGHT	260 x 130 x 180mm. 4.5kg with batteries.

DECADE OSCILLATORS



TG66 SERIES

TG66A Mains & battery model. TG66B Battery model.

FREQUENCY	0.2Hz to 1.22MHz on four decade controls.
ACCURACY	±0.02Hz below 6Hz. ±0.3% from 6Hz to 100kHz. ±1% from 100kHz to 300kHz. ±3% above 300kHz.
SINE OUTPUT	5V rms down to 30μV with Rs = 600Ω.
DISTORTION	<0.15% from 15Hz to 15kHz. <0.5% at 1.5Hz and 150kHz.
METER SCALES	2 Expanded voltage & -2/+4dBm.
SIZE & WEIGHT	180 x 260 x 180mm. 5.5kg.

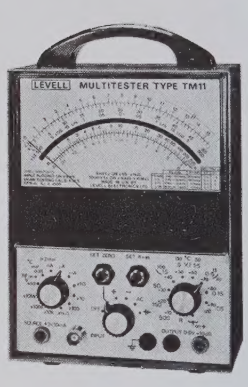
INSTRUMENT ACCESSORIES

POWER UNITS	Versions are available to allow all instruments to run on AC mains instead of batteries.
LEATHER CASES	Available for the following instruments. TM3/6/8/9/12/14 and TG152/200.
HV PROBE	50kV peak AC or DC for TM8/9/11.
RF PROBE	20kHz to 1GHz used with TM11 to detect 10mV to 500V.
T CONNECTOR	Type N connector for use with RF Probe.
TEMPERATURE PROBE	Ni Cr/Ni Al thermocouple with range from -150°C to +400°C for use with TM11.

ELECTRONIC MULTITESTER

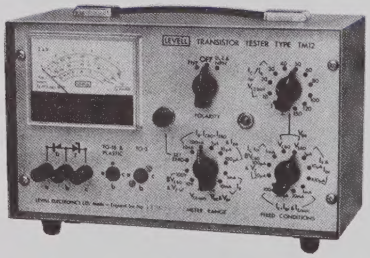
TM11

AC V, I & dB	50μV/500V fsd, 50pA/500mA fsd, -90dB/+50dB mid scale. Acc.±1.5% fsd above 500μV & 500pA. Response 3Hz/200kHz above 500μV and 500nA. Input R = 100MΩ on volts.
DC V, I & NULL	150μV/500V fsd, 150pA/500mA fsd, polarity reversible. Acc.±1.5% fsd above 500μV & 500pA. Input R = 100MΩ on volts. 5 Null ranges have centre zero lin/log scale covering ±4 decades.
RESISTANCE	0.2Ω/10GΩ in 7 ranges, polarity reversible. Low test voltage for solid state circuits.
LEAKAGE at 3V	Uses 3V source with current ranges to test capacitors, diodes and resistance up to 100GΩ.
V DROP at 10mA	Uses 10mA source with voltage ranges to test diodes, LED'S and resistance down to 10mΩ.
HIGH VOLTS	1.5kV/50kV fsd AC/DC using HV Probe type TP1.
RF VOLTS	0.5V/500V fsd 10kHz/1GHz using RF Probe type TP2.
TEMPERATURE	-150°C/+500°C fsd in 7 ranges using Temperature Probe type TP4.
HIGH CURRENT	1.5A/50A fsd AC/DC using Current Shunt type TP5.



The instrument operates from a 9 volt battery, life 1000 hrs., or AC mains when an optional Power Supply Unit is fitted. Size is 240 x 250 x 80mm. Weight is 1.75kg. Meter scale length is 140mm.

TRANSISTOR TESTER



TM12

Tests bipolar transistors, diodes and zener diodes. Measures leakage down to 0.5 nA at 2V to 150V. Current gains are checked from 1μA to 100mA. Breakdown voltages up to 100V are measured at 10μA, 100μA and 1mA. Collector to emitter saturation voltage is measured at 1mA, 10mA, 30mA and 100mA for I_C/I_B ratios of 10, 20, 30. The instrument is powered by a 9V battery.

TRANSISTOR RANGES (PNP OR NPN)

I_{CBO} & I_{EBO}: 10nA, 100nA, 1μA, 10μA and 100μA f.s.d. acc. ±2% f.s.d. ±1% at voltages of 2V, 5V, 10V, 20V, 30V, 40V, 50V, 60V, 80V, 100V, 120V, and 150V acc. ±3% ±100mV up to 10μA with fall at 100μA < 5%+250mV.

BV_{CBO}: 10V or 100V f.s.d. acc ±2% f.s.d. ±1% at currents of 10μA, 100μA and 1mA ±20%.

I_B: 10nA, 100nA, 1μA ... 10mA f.s.d. acc. ±2% f.s.d. ±1% at fixed I_E of 1μA, 10μA, 100μA, 1mA, 10mA, 30mA, and 100mA acc. ±1%.

h_{FE}: 3 inverse scales of 2000 to 100, 400 to 30 and 100 to 10 convert I_B into h_{FE} readings.

V_{BE}: 1V f.s.d. acc. ±20mV measured at conditions on h_{FE} test.

$V_{CE(sat)}$: 1V f.s.d. acc. ±20mV at collector currents of 1mA, 10mA, 30mA and 100mA with I_C/I_B selected at 10, 20 or 30 acc. ±20%.

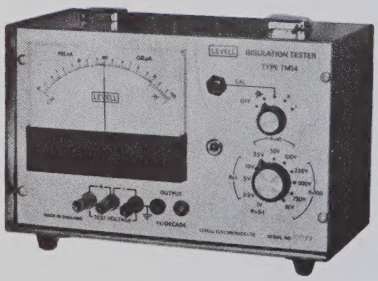
DIODE & ZENER DIODE RANGES

I_{DR}: As I_{EBO} transistor ranges.

V_Z: Breakdown ranges as BV_{CBO} for transistors.

V_{DF}: 1V f.s.d. acc. ±20mV at I_{DF} of 1μA, 10μA, 100μA, 1mA, 10mA, 30mA and 100mA.

INSULATION TESTER



TM14

A logarithmic scale covering 6 decades is used to display either insulation resistance or leakage current at a fixed stabilised test voltage. The current available is limited to a maximum value of 3mA for safety and capacitors are automatically discharged when the instrument is switched off or to the CAL condition. The instrument operates from a 9V internal battery.

RESISTANCE RANGES

10MΩ to 10TΩ (10^{13} Ω) at 250V, 500V, 750V and 1kV.
1MΩ to 1TΩ at 25V, 50V and 100V.
100kΩ to 100GΩ at 2.5V, 5V and 10V.
10kΩ to 10GΩ at 1V.
Accuracy ±15% +800Ω on 6 decade logarithmic scale.
Accuracy of test voltages ±3% ±50mV at scale centre.
Fall of test voltages < 2% at 10μA and < 20% at 100μA.
Short circuit current between 500μA and 3mA.

CURRENT RANGE

100pA to 100μA on 6 decade logarithmic scale.
Accuracy of current measurement ±15% of indicated value.
Input voltage drop is approximately 20mV at 100pA, 200mV at 100nA and 400mV at 100μA.
Maximum safe continuous overload is 50mA.

MEASUREMENT TIME

< 3s for resistance on all ranges relative to CAL position.
< 10s for resistance of 10GΩ across 1μF on 50V to 500V.
Discharge time to 1% is 0.1s per μF on CAL position.

RECORDER OUTPUT

1V per decade ±2% with zero output at scale centre.
Maximum output ±3V. Output resistance 1kΩ.